TECHNICAL REPORT NO. 2

Suitability Factors of Illustrative Media

By

ERWIN RAISZ

Senior Researcher

Project NR 088 007

Contract Nonr-474(03)

Between Geography Branch

Office of Naval Research

and

Virginia Geographical Institute

University of Virginia

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Project research under Contract Nonr-474(03),
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Office of Naval Research, Department of the
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INTRODUCTION

A series of experiments on illustrative media was carried out at the Virginia Geographical Institute in Charlottesville beginning in November 1952.* The purpose of these tests was to check the suitability of such drawing materials for various uses at small research centers. No attempt was made to pass absolute judgement on the merits of these media. Rather, the aim was to design a simple practical set of tests to show the interaction of pens, inks, papers, and plastics under conditions simulating those in which cartographers and draftsmen actually use them, and to set up patterns for testing other like media. Particular emphasis was placed upon the needs of those working with the fine lines used for hand lettering, symbols, land surface portrayals, etc. These problems, related to the development of good illustrations for reports, are of especial interest to the smaller research centers because they commonly lack specialized personnel and facilities for such work.

METHODOLOGY

I. GENERAL -- The essentials of this methodology are to select the commonly variable characteristics of the most used illustrative media and then devise and apply tests of those qualities. These tests were confined to certain few materials selected somewhat arbitrarily - in part because of ready availability and partly because of limited time for experiment.

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* Especial thanks are due to Mrs. Elizabeth M. Thrower for great aid in processing and recording the tests, and to the senior staff of the Virginia Geographical Institute for their support, consultation, and aid during the testing and preparation of this report.

II. LIST OF MATERIALS -- Following is a list of the trade names, types, and manufacturers of the various media tested. Most of these materials can be purchased at stores carrying engineering and artists supplies.

TRADE NAME	TYPE	MANUFACTURER
1. Black Inks:		
Artone - Fineline	Waterproof	Artone Color Corp. New York 12, N. Y.
Higgins - Am. India	Waterproof	Higgins Ink Co. Inc. Brooklyn 15, N. Y.
Pelican - Black	Graphos Concentrate	Gunther-Wagner Co. Hanover, Germany
Grumbacher - India	Waterproof - Can be used on Acetate	M. Grumbacher Inc. New York - Toronto
Craftint 66	Extra Waterproof - Jet Black - Custom made - Colloidally Perfect	Craftint Mfg. Co. E. 152nd St. at Collamer Avenue Cleveland, Ohio
Craftint 111	Waterproof - Non-perm. for Plastics	Craftint Mfg. Co. Cleveland, Ohio
Craftint 155	Opaque Masking	Craftint Mfg. Co. Cleveland, Ohio
G.P.O.	Waterproof for plastics	Govt. Printing Office Washington, D. C.
Artone Acetate	Opaque Permanent	Artone Color Corp. New York 12, N. Y.
2. White Inks and Paints:		
Craftint - Super White No. 37	Use in brush, pen or air brush.	Craftint Mfg. Co. Cleveland 10, Ohio
Weber - Reproduction White	Process white for Commercial Art	F. Weber Co. Philadelphia, Pa.
Carter's - White	Tempera Colors 139	The Carter Ink Co. Boston, Mass.
Johnston - Special Grade Snow White	Pen, brush, or air brush	Johnston's Products Rochester, New York

TRADE NAME	TYPE	MANUFACTURER
3. Papers and Plastics:		
#A. Strathmore Drawing Board	Kid finish, one ply	Keuffel & Esser Co. New York
#B. Union Drawing Paper #55	Slightly grained	Dietzgen Co. New York
#C. Transcal Hot Pressed Board	Illustration Board	London, England
#D. Gateway Tan Glass Paper	Rough blotter-like paper	Wiggins Teape Ltd. Mansell Street London, England
#E. Winston Tracing Paper	Inexpensive, semi-transparent	Dietzgen Co. New York
#F. Ageproof Vellum	Fine-tooth surface	Dietzgen, N. Y.
#G. Geopaper #256	Weatherproof, semi-transparent vellum	Geo-Optic Co. 170 Broadway New York 38, N. Y.
#H. Vinylite	Plastic, mat surface	Bakelite Corp. 30 E. 42nd Street New York
#I. Dyrite M.P.	Mat polish, rubbed with VAL-U-TONE sand	Direct Reproduction Corp. 68 Gansevoort St. New York 14, N. Y.
#J. Dyrite M. P.	Mat polish, untreated	Direct Reproduction New York 14, N. Y.
#K. Di-Noc Photo Plastic	Transparent, mat surface	The Di-Noc Co. Cleveland 12, Ohio
#L. M.M. Glass Laminate	Transparent, mat surface	Scranton Plastic Laminating Corp. 3218 Pittston Scranton, Pa.
#M. Stabilene Fiber Glass	Laminated with plastic	Keuffel & Esser New York
#N. Perma-Scale Glass Cloth	Opaque - laminated with plastic	Dietzgen New York

TRADE NAME	TYPE	MANUFACTURER

3. Papers and Plastics (cont.):

#O. Perma-Scale Glass Cloth	Transparent - laminated with plastic	Dietzgen New York
#P. Craftint Clear Acetate	Transparent smooth finish	Craftint Mfg. Co. 50-18 Vernon Blvd. Long Island 1, N.Y.
#Q. Photostat Grade K Paper	Opaque	Photostat Corp. U. S. A.
#R. Photo-paper	Smooth	From U.S. Air Force

4. Pencils:

Koh-i-noor	H - grade	L. & C. Hardtmuth U. S. A.
Venus	H - grade	American Pencil Co. New York
Turquoise	H - grade	Dietzgen Co., N. Y.
Castell	H - grade	A.W. Faber, Germany
Anadel	1995 - Dixon black	J.Dixon Crucible Co. Jersey City, N. J.
Wolff	H - Carbon Drawing	Royal Sovereign Pencil Co., England

5. Pen Points:

Esterbrook - 355	Art and drafting pen	R. Esterbrook Co. Camden, N. J.
Gillott - 290	Drawing pen	Joseph Gillott London, England
Hunt - 104	Drawing pen very fine	C. Howard Hunt Pen Co. Camden, N. J.

III. TESTING METHODS AND PROCEDURES -- How does a certain ink behave on a given type of paper or, under certain circumstance, what ink will behave in a desired way on a drawing surface? Such questions are often encountered at small research centers when project results and ideas are being prepared for report in written word and graphic illustration. To help in answering these questions or to set up some "measuring stick" to aid in evaluating new graphic materials, a variety of experiments was run on: nine black inks, four white inks or paints, eighteen different papers, three kinds of pens, and six pencils. Altogether about 4000 tests were recorded; somewhat less than the total number made because some proved meaningless and were discarded. Those recorded and retained for reporting fall readily into five groups - one group of interaction tests and four groups of additional tests on inks, "papers", pens, and pencils.

1. Interaction Tests: In studying the interaction of inks with paper and plastic surfaces, six inks only (Artone Fineline, Higgins Am. India, Pelican, Grumbacher India, Craftint 155 and G.P.O. acetate) were tried in several ways on eighteen surfaces. Primarily these tests checked such variable characteristics as finesse, density, and erasability. By finesse is meant the ability to make very fine lines which do not spread and, under magnification, remain sharp and narrow with clean edges. Density means the even opaqueness of the line and is evaluated here by viewing under magnification, first with light above the paper and then with light through from behind the paper. A five-power lens was used for the experiments. Although the erasers themselves were not tested, the two used repeatedly throughout these experiments are both Eberhard Faber: 101 Pink Pearl (soft) and 112 Ruby (hard).

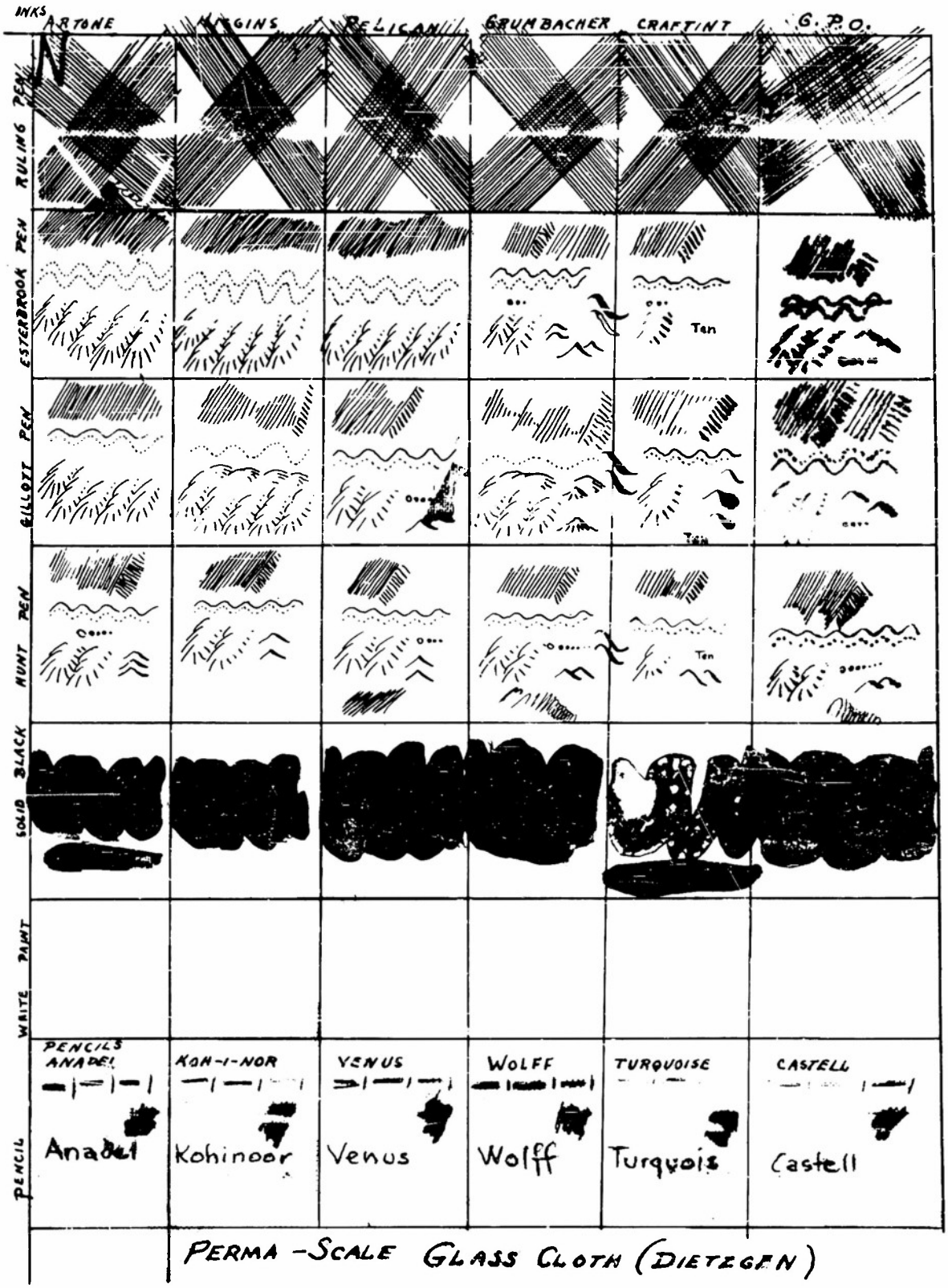

TABLE 1. Reproduction of Sample Test Sheet

During the experimentation, a relatively simple test sheet for each paper or plastic specimen was evolved. A 6 inch by 8 inch piece of the material to be tested, was divided vertically into six columns - one for each ink - and horizontally with blocks for the different pens, solid spots, white paints and pencils. Table 1 is a reproduction of such a test sheet. Four distinct steps were carried out.

First, with each ink two sets of very fine parallel lines crossing each other were drawn with a ruling pen. Lines were then rated on finesse and density. Resistance to erasure was judged after a hard eraser had been rubbed for 30 seconds with even strokes along a straightedge. On Table 1, the light areas at the place where the two sets of lines cross indicate this test.

Second, with each of three pen points (Esterbrook 355, Gillott 290 and Hunt 104) closely-set fine lines, a series of dots, some hachuring, tiny circles and lettering were drawn. Again finesse and density were judged and erasability tested, this time with a soft eraser applied for one minute.

As a third step, solid spots of each of the black inks were painted on with brushes. Care was taken to apply each spot with the same thickness, then the paper was tilted and superfluous ink blotted off. The black patches were tested for surface density (lighted from above) and "trans-density" (lighted through paper). Eraser tests were made with soft erasers.

Fourth, four white inks (Craftint, Weber, Carter, and Johnston) commonly used for "painting out" irregularities in drawings, were applied to the different paper media with a brush. They were then checked under the five-power lens for density and coarseness of grain. The "staying-

on" qualities were judged after a single brush stroke over the ruling-pen lines in Artone ink. See the lower part of upper left-hand box on Table 1 for evidence of this test. Chipping and adhesion were tested by rubbing for 30 seconds with a soft eraser and by folding the paper through the white patch.

2. Supplementary Ink Tests: A series of tests involving no interaction of inks with papers was run separately. The same six inks used in Interaction tests were tested for capillarity, fluidity, and average drying time.

First, capillarity was checked as an indication of spread into paper fibers. Strips of blotter, 1/4 inch wide, were dipped into the bottles of ink, just touching the surface; then the distance the ink ran into the blotter was measured. This was repeated several times for each ink and averages recorded.

In the second step, fluidity was tested by two different methods. A standard narrow-blade ruling pen, opened to .13 cm., was filled until the ink began to drop from it. The height of the column of ink in the pen was measured in centimeters. The other method was to drop equal amounts of each of the six inks onto a smooth acetate sheet which was then slowly tilted until the ink ran. The angle of tilt was observed in each case. The more viscous inks required a steeper inclination before the drops began to run. To insure getting the same amounts of the different inks, six identical ruling pens were equally filled.

Drying time was the third quality judged in this series of tests. As a starting point, ink runs on acetate sheets, tilted 60°, were timed for drying. Then drying time for ink patches was observed; but this

was not a reliable test, mostly because it varied too much according to the thickness of the spots. Better results were obtained when thick lines (about .6 cm.) were drawn with a brush, and drying times noted. A similar test was also carried out with fine lines (approximately .1 cm.) made by equally-filled ruling pens. These tests gave somewhat divergent results, so were repeated several times on different days under different temperature and humidity conditions, and an average of the results was recorded. Drying of inks in pens was also checked. Six pens of the same kind were dipped equally into the inks; then fine short lines were drawn at 1/4 minute intervals. Length of time the pens continued to mark was averaged and recorded for each ink. For this, both ruling pens and drawing pens were used.

A fourth supplementary ink test checked waterproofness of the various kinds of inks. Actually this test was made on some of the test sheets, but bears no relation to reactions with paper samples. Super White Craftint ink was gently rubbed with a brush onto the six black patches made in step 3 of the Interaction tests. After a period of one minute the grayness was noted in order to judge how much of the black ink "ran" into the white. Those inks which ran only slightly were rated most waterproof.

3. Additional Tests on Papers and Plastics: A variety of tests were conducted on the eighteen "papers" listed on pages 3 and 4. In order to simplify the tests and their later evaluations, paper and plastics were divided, according to broad similarity of type, into five categories as follows: (1) drawing papers - Strathmore, Union, Transeal Hot Pressed Board, Gateway; (2) tracing papers - Winston,

Ageproof, Geopaper; (3) transparent plastics - Vinylite, Dyrite (both sanded and mat surface), Di-Noc, Craftint Clear Acetate; (4) glass laminate papers - M.M. (Scranton), Stabilene, Perma-Scale (opaque and transparent); and (5) photo papers - one photograph paper and one photostat paper.

For all "papers", such properties as thickness, smoothness, and transparency were readily judged by eye and fingertip and rated arbitrarily by comparison with each other. Flatness was judged by observing how closely the unfastened paper stayed to the drawing board.

More elaborate tests were carried out to measure: recovery from rolling, tearing strength, and water absorbency including curling and stretching. First, samples of each "paper" were rolled into tubes one inch in diameter and held that way for one hour. After release, observations were made to see how completely the paper flattened out. Next, tearing strength was judged by hand tears in the edge of the sample sheets. More accurate results could have been obtained had a tensile-tester been available, but since it was not, the paper's resistance to tear was judged by feel on a comparative basis. As a last step, several tests were run to check the reactions of papers and plastics to water. Water was painted with one brush-stroke down the center and across one corner of each paper sample. Absorbency, wet-curling and wrinkling were observed - both while still wet and again after drying. Next, to measure stretching and shrinking of "papers", 7 inch lines were drawn lengthwise and crosswise on each sheet. Sheets were then submerged in water for 30 minutes. Measurements of length of lines were made while material was still wet, after four hours drying, and again after five days. In such tests measurements are expressed in 1/100 inch.

4. Tests on Pen Points: The three pens (Hunt 104, Esterbrook 355, and Gillott 290), used on the test sheets, were judged on flexibility, resiliency, and wearing ability. These new pens, used for the fine line work, were subsequently examined under a ten-power microscope for signs of wear. Pens were then pressed almost to the breaking point. Since no mechanical equipment for applying even pressure was available, this experiment was carried out and recorded by one person so as to eliminate variability as much as possible. Flexibility was judged on how easily the prongs spread, and resiliency (elasticity) on how perfectly they closed again after release of pressure.

5. Tests on Pencils: Six pencils - four graphite type marked H (Castell, Venus, Turquoise, Koh-i-noor), one carbon (Wolff) and one thin-line wax crayon (Anadel) - were line tested for finesse, density, and resistance to erasure. These tests were made in the lower rectangles on the Interaction test sheets (Table 1). Lines in two directions were drawn with equal pressure; a solid patch and some lettering was made. Finesse and density were judged after examination of lines with a magnifying glass - a similar process to that used in testing inks. Pencil marks were then subjected to a soft eraser applied with three even strokes to determine resistance to erasure.

A supplementary writing test on pencils was also run. The same sentence was hand-written on paper with each pencil, after which finesse of line, density and wearing of pencils was observed and recorded.

IV. GRADING SYSTEM -- For these tests a standard system of grading, A through E, was set up. Many of the tests were repeated several times

TABLE 2. RECORDING OF TESTS

Key to papers and plastics

#A	#B	#C	#D	#E	#F
#G	#H	#I	#J	#K	#L
#M	#N	#O	#P	#Q	#R

Arrangement used in tables below

#A Strathmore drawing paper
#B Union drawing paper
#C Transeal hot pressed board
#D Gateway tan glass paper
#E Winston tracing paper
#F Ageproof vellum
#G Geopaper (vellum)
#H Vinylite (plastic) mat surface
#I Dyrite - sanded surface
#J " " mat "
#K Dy-Noc photo plastic, mat
#L M.M Glass laminate

For ink tests see also Table 3.

Inks

Fluidity, Water proofness, Density, Capillarity

Artone fineline drawing ink

Higgins Am. India ink

Pelican Graphos conc. ink

Ruling pen

Finesse, Density, pen tests, Soft eraser, Hard eraser

Esterbrook 355 pen

Gillott 290 pen

Hunt 104 pen

Solid black

Surface density, Trans-density, Soft eraser

White inks

Staying on, Density, Soft eraser

Craftint Super white

Weber Reprod. wh.

Carter Tempero wh.

Pencils

Finesse, Density, Soft eraser

Koh-i-noor

Turquoise

Castell

Paper tests

See also Table 4.

Negative values

Thickness, Flatness, Transparency, Smoothness

Tearing, Absorbency, Wrinkling, Recovery from wrinkling

Differencial wet stretch, lenghtwise, crosswise, Wet stretch 1/100 inches, Recovery from rolling

#M Stabilene fiber glass
#N Ferma-scale glass cloth opaque
#O " " " transp.
#P Acetate, smooth transparent
#Q Photostat paper Grade R.
#R Photo paper smooth

Supplementary tests
Artone acetate ink

Ruling pen

Solid black

Supplementary tests on Craftint 66 are on Table 3

Grumbacher
India drawing ink

Craftint 155
masking ink

G.P.O. ink
acetate ink

Artone
acetate ink

Craftint 66
drawing ink

Johnston
snow wh.

Venus

Anadell
wax crayon

Wolff
carbon crayon

mean contraction

Lengthwise Stretch Lengthwise
Recovery
4 hours dry 5 days dry
Crosswise 1/100 inches Crosswise

Pens

	Wearing	Elasticity	Flexibility
Esterbrook 555	A-	C	B
Gillott 290	A*	A	A
Hunt 104	A	B	C

* Wears unsymmetrically

White inks

	Chipping	Finesse of grain
Craftint	B	C
Weber	B+	A
Carter	C	B
Johnston	E	A

Pencil hand-writing test

	Wearing I	Wearing II	Finesse	Density
Kohinoor	A	A-	B	C
Turquoise	A	B	B+	C-
Castell	A+	A-	B+	B-
Venus	B	C+	B-	A-
Anadel	C	C	C	B
Wolff	C-	C	C-	A

Grade of hardness for all pencils is N° H

Grading:

A+ = 4 1/3	C+ = 2 1/3	E+ = 1/3
A = 4	C = 2	E = 0
A- = 3 2/3	C- = 1 2/3	E- = -1/3
B+ = 3 1/3	D+ = 1 1/3	
B = 3	D = 1	
B- = 2 2/3	D- = 0 2/3	

Ch = chipps off N = no contact with paper

For detail on papers, pens, inks and pencils see next pages

and an average grade recorded in the table. To aid in averaging, a numerical equivalent was assigned to the letter grade as follows: A=4, B=3, C=2, D=1, E=0. A detailed list of values is found also on Table 2, page 12-13. In grading the various properties of media, A or the highest rating was arbitrarily assigned on the basis of comparison with other materials tested. For example, in ink tests on density, the blacker and more opaque lines received the higher marks. Or, in the case of resistance to erasure, lines which held up strongest during erasing were graded highest.

V. RECORDING OF RESULTS -- Table 2 is a complete recording of the results of all these tests. This table has been worked out to show the interaction of one medium relative to others, and to show the relative usefulness for certain specialized purposes of each group of media.

The upper two-thirds of Table 2 is given over to the results of the interaction tests. Each vertical column is headed by the name of the ink tested and by an average rating of its fluidity, density, waterproofness and capillarity. The horizontal belts of column-width rectangles are for the different kinds of pens named on the left. Each of the resulting rectangles is subdivided into squares for the eighteen "papers" which can be identified by the "Key to papers and plastics" located in the upper left-hand corner of Table 2. Within the small squares are found the grade ratings for finesse, density, soft eraser and hard eraser arranged according to the small diagram of "pen tests" - left hand of page.

As an example in the use of this table, observe how Artone, Craftint 155 and Pelican inks behave on Ageproof vellum. First note Ageproof

vellum is identified as #F, then find location of that square on the "Key". By studying the grades in the squares of that same location in the columns labeled Artone, Pelican and Craftint 155, the comparison can be made.

Results of tests with solid spots of black ink (5th belt down), white inks (6th belt down), and pencils (7th down) are also recorded for each of the eighteen papers and plastics. In each case the small compartment at the left indicates what type of test was graded. For the white inks and pencils, each column is headed by the trade-name identification.

Besides the interaction tests, several other supplementary or special tests are here recorded. At the bottom of this tabulation page are the results of additional tests on papers and plastics. Special tests on pens, white inks, and pencils are recorded at the right.

As this table is rather complex, separate tables for summarizing tests on inks (page 16) and on papers and plastics (page 18) are included to help clarify the results and methods used.

SUMMARY AND EVALUATION

I. GENERAL -- The results of these tests should in no way be considered as commercial rating of any one product. As stated earlier in the text, an attempt has been made to show how various media behave under conditions of cartographic and illustrative use - especially at small research centers. By use of the tables, comparisons of qualities and attributes can be made fairly easily. Only rather common suitability questions are answered by these tests; but some methods for further experimenting on factors and media of the reader's choice can be found here.

II. SUITABILITY SUMMARIES -- Following are general summaries of some characteristics of media tested.

1. Black Inks: Table 3 summarizes results of tests on black inks, both ordinary carbon and acetate in type.

INKS (all black)	FINESSE of lines	DENSITY of pen lines	DENSITY of solid spots	RESISTANCE to soft eraser	RESISTANCE to hard eraser	WATERPROOFNESS	CAPILLARITY	FLUIDITY	DRYING* on vellum	DRYING* ruling pen lines	DRYING* spots on acetate	DRYING* in pen
ARTONE Fineline	3.18	3.71	2.87	1.67	.78	B-	A-	A	1.20	1.2	4.00	4.25
HIGGINS AM. INDIA Waterproof	3.39	3.83	2.87	1.64	.94	C	B	B	1.00	1.1	3.50	1.75
PELICAN GRAPHOS India	3.34	4.01	3.43	2.07	1.05	C	B+	A-	2.00	1.1	3.75	1.50
GRUMBACHER INDIA Waterproof	3.12	3.53	3.17	1.59	.75	B	B	B	.75	1.5	5.25	2.50
CRAFTINT 66 JET Drawing	3.05	2.85	3.67	2.15	1.00	B+	B+	B+	1.50	1.0	4.50	1.75
CRAFTINT 155 Opaque Masking	2.60	2.33	4.02	1.00	1.51	E+	B	E	over 5		over 10 minutes	
GOVT. PRINTING OFFICE	1.39	1.51	2.13		2.17	A	A	C+	over 15			
ARTONE ACETATE						A		D	3.50			

* Drying times are averages from several tests. Grading: A=4 B=3 C=2 D=1 E=0
First five columns are averages from tests on all 18 papers and plastics.

TABLE 3. Summary of Tests on Black Inks

There is relatively little difference between most of the commercial "India" or carbon-type inks in general use. Artone Fineline is free-running and penetrates drawing paper deeply. Very fine lines can be drawn. On plastics, where the ink cannot penetrate, it has a slight tendency to spread. In pens, Artone Fineline keeps running longer than the others tested but, if allowed to dry, it becomes very hard and

difficult to remove. Higgins is a well balanced, good, all-around ink deficient only in waterproofness. It is easy to clean from pens. Among the inks tested, Pelican rates highest in density and second in fluidity. It too is deficient in waterproofness and dries in a pen faster than some of the others. Under conditions at this conter, Grumbacher tested slightly below the average in density and fluidity and is slower in drying. Although advertised for use on acetates, it adheres to them no better than the other general inks. Craftint 66 seems to be highly waterproof, excells in finesse, and is average in density and fluidity. As this ink was received late, only simplified tests were run on it.

Acetate inks have very different qualities from the ordinary carbon inks and must be appraised differently. To adhere to non-absorbent plastics, these inks must dry more slowly and partially dissolve the plastic surface. Among the acetate inks only Craftint 155 and Government Printing Office ink were run through the complete series of tests, with the India inks. An additional ink, Craftint 111, is known by tests made later than those tabulated, to react identically to Craftint 155 except that 155 is water soluble and therefore not amenable to correction with opaque white inks. Both Craftint inks are superior in density but not adaptable for fine line work because they clog all types of pens too rapidly. Craftint 155 and G.P.O. inks, designed primarily for use on plastics, do not work well on papers. In studying Table 3, it is noticed that both of these inks received high ratings in capillarity and disproportionately low ratings in fluidity. A tendency toward imbalance in these two inks is caused by the presence of both tar and a solvent. The solvent runs very freely and the tars make them less fluid. Thus, because of evaporation in use, much of the behavior of both

MATERIAL	THICKNESS	FLATNESS	TRANSPARENCY	SMOOTHNESS	RECOVERY FROM ROLLING	TEARING STRENGTH	WATER ABSORBANCY	WRINKLING	RECOVERY FROM WRINKLING	FINENESS OF FINEST LINES	DENSITY OF FINE LINES	SOFT ERASER one minute	HARD ERASER one-half minute	STRETCH after soaking	REMAINDER STRETCH after drying	STRETCH DIFFERENCE in two directions	REMAINDER DIFFERENCE after drying	REMAINDER DIFFERENCE after five days
										averages from 6 inks				in 1/100 inches				
#A	B	A-	C	C	C-	C	A	C	A	3.34	3.2	3.54	2.34	21 6	1 0	15	1	
#B	B+	A-	D	C	D	C	A	C	A	3.74	3.8	2.60	2.54	6 21	- 2 - 4	15	2	
#C	A	A	E	A-		A	C	A	A	3.80	3.9	1.76	1.08	-1 0	2 - 4	-1	-2	
#D	A-	A-	D-	D	D+	D	A	A	A	4.00	3.8	.28		7 7	- 4 0	0	-4	
#E	D	C	B	C	D	D	B	E	D	3.80	3.6	2.20	1.20	57 8	-12 -12	49	0	5
#F	D+	B	B	C	C	D+	B	E	D+	4.00	3.5	2.28	1.40	0 32	- 6 - 6	32	0	
#G	C	B	B	B	C-	D	C	D	D+	4.00	3.7	.06	1.40	42 8	- 6 - 3	34	3	1
#H	B	A	A	A-	A	B	D	A	A	3.80	3.2	.00	.02	7 7	2 2	0	0	
#I	B+	A	A-	B	A-	A	E	A	A	4.00	3.3	.16	.42	0 0	2 2	0	0	
#J	B+	A	A-	B+	A-	A	E	A	A	4.00	3.0	.40	.98	0 0	1 1	0	0	
#K	B	A	A-	A-	A-	B	E-	A	A	2.28	1.8	.60	.00	8 8	2 - 2	0	4	
#L	B	A	A-	B	A-	B+	E	A	A	3.84	3.5	1.88	.48	3 3	2 0	0	2	
#M	B-	A	A-	B	A	A-	E	A	A	3.40	3.3	3.00	.40	2	1			
#N	B-	A	B-	B+	A-	A-	D+	A	A	3.60	3.6	3.28	1.54	3 0	0 0	3	0	
#O	B-	A	A-	B+	A-	B+	D+	A	A	4.00	3.5	3.28	.56	0 0	0 0	0	0	
#P	C	B-	A	A	A	B	E	A	A	3.40	3.3	.20	.08	8 7	3 4	1	1	1
#Q	C+	B-	C	B+	D+	D-	B	C	B	4.00	3.8	3.22	1.80	6 9	- 2 - 1	3	1	
#R	B	B-	D	A	D+	D-	C	B	B-	3.80	3.8	1.88	0	2 8	- 3 0	12	-3	

TABLE 4. Summary of Tests on Papers and Plastics

these inks is dependent upon the amount of solvent present. Artone Acetate, the fourth acetate ink tested, works similarly to the general or carbon inks except for greater density and slower drying. When dry, however, it is highly waterproof - almost like laquer. For fine-line work it is much better than the other acetate inks tested.

2. White Paints and Inks: White inks and paints are commonly used in correcting irregularities by "painting out" unnecessary black lines. Thus opaqueness (density) and "staying on" are their desirable qualities.

None of the commercial whites tested are entirely satisfactory. The ordinary white tempera colors like Carters seem to be more opaque and stay on better than Craftint Super White 37 or Weber Reproduction White, even though the latter two are especially designed for this purpose. On the other hand, Carters is of coarser grain and has a tendency to form lumps. Johnston's white ink opaques fairly well, but chips badly. Weber is finely grained, but less opaque than Craftint. Table 2 gives the detailed ratings for each testing of these four white inks.

3. Papers and Plastics: The qualities of papers and plastics tested are so different that they are evaluated here under the five separate headings listed on pages 8 and 9. The letter preceding the trade name corresponds to that used in designating the papers and plastics in both Table 2 and Table 4

a. Drawing Papers: #A Strathmore and #B Union are unmounted general-use drawing papers. They absorb ink fast and allow fine, dense lines. Both stretch enormously in water, but their recovery is amazing.

Once rolled, however, they do not straighten out easily. Strathmore paper can be straightened out by rolling backwards over a tube, but with the Union paper, attempts to flatten without breaking the surface are almost impossible. The #C Transeal Hot Pressed board is rather unique in its qualities. It is so stiff and thick that it cannot be rolled, but keeps its shape well against scale distortion. Absorbent enough for fine line work, it still has a pleasant smooth surface. This board never flattened out completely after immersing. #D Gateway Tan Glass paper has a rough almost blotter-like surface and therefore was not tested with ruling pen lines. Tests proved it very amenable to fine-line work with a drawing pen as well as to soft pencil or pastel. It avoids distortion and lies flat, but has very little elasticity - if rolled, it breaks easily. Erasing damages the whole surface.

b. Tracing papers: #E Winston tracing paper, #F Ageproof vellum, and #G Geopaper were next tested. All three lack "flatness". Less transparent than the plastics, the vellum is better than the others in this respect. Each lacked the ability to recover from rolling and wrinkling. After immersion, the Winston tracing paper expanded 8% and shrank in drying about 3% in one direction and 2 2/3% in the other. The vellum, which should be distortion proof, showed no stretch in water in one direction, but 4% in the other and in recovery shrank in both directions 1%. Geopaper, containing some plastic, is similar in most qualities to the vellum, but is slightly less absorbent. These tracing papers and vellums are not reliable for overlays or other work where retention of exact shape and scale is important. They are, however, excellent for layouts, sketches, and for transferring copies. They are much cheaper than other media.

c. Transparent Plastics and Acetates: #H Vinylite, #I Dyrite-sanded, #J Dyrite-mat, and #K Di-Noc make up the first part of this group. All have mat surfaces with remarkable transparency. The Dyrite was tested both untreated and treated by rubbing with a sand called Val-U-Tone. In all standard tests these three plastics are much alike - lie flat on the drawing board, recover from rolling, do not wrinkle and recover from wetting with a minute stretch (less than .3%) equal in both directions. All plastics, however, have some less desirable qualities. As they do not absorb ink, lines tend to spread and are less dense, and are more easily erased or chipped off than on drawing papers. Plastics are sensitive to fingerprints. Dyrite is somewhat brittle - if dropped edgewise it may shatter. Such plastics as these are most useful for cartography where large amounts of Zipatone, cellotype and pasted-on symbols are used with a minimum of pen-line work. Plastics are the best media for color overlays because of their transparency and retention of shape and scale.

A smooth acetate sheet, #F Craftint Clear, was also tested for inks and pens. As a drafting medium, it excells in transparency, but its poor absorbency makes it hard to use for fine-line work. Lines are almost too easily erased and chipped off. Artone Acetate ink adheres better than Craftint 111, and the G.P.O. ink sticks excellently but has to be put on heavily to be opaque. Acetate is not as distortion- or shape-proof as other plastics and recovery is incomplete, about ½%, but almost the same in both directions. If the acetate comes from a roll, the differential stretch may be larger.

d. Glass Laminates: These are generally a glass fiber cloth covered on both sides with a thin layer of plastic. This plastic either

has tiny holes or is treated to let through the ink which will be absorbed by the glass cloth center. Thus these glass laminates combine the transparency, shape-proofness, and elasticity of the papers - a nearly ideal combination. There was little choice between the four laminates. The #L K.M. (Scranton) has an excellent surface for fine line work, is slightly less transparent than the others, but recovers from rolling less well. It differs from the others in that instead of a woven glass cloth, it has a thin layer of glass felt between the plastic surfaces. The #M K-E Stabilene Fiberglass and Dietzgons Perma-scale (#N opaque and #O transparent) are almost identical. Dietzgens Perma-scale is a little heavier and smoother, but both are almost perfectly distortion-proof. The opaque Dietzgen laminate is, in all other qualities identical to the transparent one. The Stabilene has tiny holes which let more ink into the center layer, thus blotches cannot be erased at all, however, fine lines do erase. In most respects, possibly excepting price, the laminates tend to be superior.

e. Photo Papers: Finally one photostat paper and one photograph paper were examined. The photostat paper acted similarly to any thin smooth drawing paper except that it never completely recovered from rolling. It recovered from wetting with only a .01% shrinkage in both directions, in contrast with the photograph paper which had a 0.5% permanent shrinkage in one direction. The photostat paper tested here is a special make (Grade R) used by libraries. The smooth photo paper took fine lines well, but ink chipped and erased off quite easily.

4. Pen Points: Only a few manufacturers specialize in the highly refined art of making drawing pens. Each, however, puts on the market

a multitude of models to take care of the varied personal preferences of users.

Only three fine-line pens were tested and all were found satisfactory. As for comparative qualities, the Hunt 104 makes by far the finest lines when new, but is also the stiffest and yields essentially no variation in line width. It is a very small pen with a semi-cylindrical body which holds the ink liquid for a long time. Esterbrook 355 is medium in stiffness. Its main drawback is a lack of elasticity; when spread, it does not spring back. Gillott 290 is very flexible, and makes a fine line. This pen point tends rather rapidly to wear asymmetrically. The Gillott 290 proves amenable for artistic use where the thickness of line has to be varied.

5. Pencils: Four graphite pencils (Koh-i-noor, Venus, Turquoise, Castell), all marked H, are remarkably alike. The tests were repeated several times upon different media, and individual variations of pencils (sometimes in the very same pencil) were often found greater than the difference between various makes. Among the four, Castell holds a point longest, Turquoise and Koh-i-noor wear slightly faster and all have similar density. Venus wears down the fastest, but is also the blackest. A Venus 2H more closely resembles the other H-grade pencils than does the Venus marked H. Castell and Turquoise seem to write a little smoother than the other two.

Nearly all graphite pencil lines tend to photograph poorly and where this is important, a carbon crayon like Wolff or a thin-line crayon like Anadel can be used. The carbon crayons are coarser, but more dense, and the lack of grease in them makes it possible to rub the

carbon lines smooth more easily. Both crayons tend to smudge, but the carbon crayons more than the wax type. Where smudging may cause trouble, a liquid plastic fixative can be used.

CONCLUSION

In small research centers, especially those working on photo-interpretation keys and the like, many problems involving the graphic support and portrayal of results for reports constantly arise. Frequently in such centers, experienced illustrative or cartographic personnel is scarce or irregularly available. It is hoped that these tests may be of some aid in solving graphic problems.

The chief value of this series of tests lies in the evaluating of some common illustrative materials for specific uses and in setting up standards against which new materials can be quickly judged. This center found that many practical questions can be answered directly with much saving of time by reference to these tests and the tables of results. For example, despite the use of "stick-up" symbols, it is often necessary to mark photographs for identification of special features. An examination of Tables 2 and 3 gives readily the comparative qualities of the various inks when used on photo papers. New drawing media are continually appearing on the market. It often saves time and work to compare these new materials to an older established one before putting it into general use. By running a simplified set of tests on the new material and at the same time running a control test on a well-known material, such as Higgens ink, the comparative properties can be quickly ascertained.

Such tests are possibly of more value to the unskilled than to the

skilled cartographer. The trainee, or unskilled draftsman, may well be guided by the test results in his selection of media for specific purposes. However, the skilled illustrator already has long established habits in the use of certain pens, pencils and papers.

In conclusion it should be repeated that these tests do not judge the merits of one media against another in the sense of rating them on commercial value. Rather they were run as aids in the selection of graphic materials for specific purposes.